Barriers for Clean Energy Projects

Maximilian Bonnici, Henry Greene, and Isabelle Bonnici

***Abstract*—Clean energy may offer a more environmentally friendly outcome than fossil fuels. However, clean energy is beset by uncertainties when the sun does not shine through and the wind does not blow. Worse still, science has not yet overcome scalability issues that are compounded by lack of technological knowhow on how to store solar and wind energy. The electrical "green-outs" of August 2020 in California are a reminder that without storage facilities for clean energy, utilities are driven to spot markets for electricity rendered from traditional sources of energy as economic setbacks occur due to compromised supplies of electricity. Without means of energy storage, new technology cannot fully replace the old. One can only hope that the dream to build a future based on renewable energy will lead to discoveries that will overcome scalability and storage issues.**

***Index Terms*—Clean Energy, climate change, prediction, storage.**

I. Existing Challenges

Climate change evokes conspiracy theories in unlikely places. For example, the *American Journal of Management* ran a whole article whose central argument was that the Restructuring of the Global Economy (ROGE) is part of a U.N. master plan which uses the public's concern about climate change to transform the global economy from a capitalist to a socialist one. The article's author laments pronouncements by world leaders that foment fear about the climate, ranging from glacial melting and flooding to heat and dryness that turn arable land into desiccated fields where nothing grows [1]. Others point out that almost half of 70 Nobel Prize-winning scientists at an international meeting refused to sign a petition in support of anthropogenic global warming (AGW) hypothesis, also known as climate change, as if refusing to sign a petition means that one holds dissenting views [2].

In 2017, the American Psychological Association diagnosed eco-anxiety as being on the rise, calling it "a chronic fear of environmental doom" [3]. There are numerous reasons for the fear. For example, massive storm surges, coupled with population growth and climate changes, could foster calamitous events leading to environmental chaos and the potential collapse of the ecosystem [4]. The increased level of carbon dioxide in the atmosphere is often cited as proof of the disaster ahead [5].

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Humans inhabit the same planet earth. Fair weather ahead for one person is fair weather ahead for all. If Armageddon materializes, everyone is doomed. As can be seen from the COVID-19 pandemic, there is no escape. Sooner or later, the weather impacts everyone as currents swirl around the globe. Therefore, three questions arise. First, will the predictions come true? Second, if yes, what could be done about them? Third, what are the ethical implications behind all this? Nobody knows the answer to the first question. Different opinions suggest lack of solid proof. There is a leap between predictions and outcomes. Heller [6] has a quotation by Richard Feynman, a theoretical physicist, in small print at the top of his blog. It says, "Science is the belief in the ignorance of experts" [7]. This is sobering as wise men who are supposed to lead others could turn out to be delusional academics gripped by unwarranted fear. Lippmann cautions in *Public Opinion* that despite the mass media sharing its findings with all, there continue to be chief factors that limit one's access to the facts [8]. These include lack of time to listen to all the views, the difficulty of understanding the world, and the common inability to fully comprehend ideas that are frequently compressed in a few lines. Take all this in a scientific setting buried under tons of data, and it is not just the public that struggles to understand what is going on but also the scientists themselves who struggle to comprehend the data.

II. Limited Methods

A problem with testing predictions is that they are increasingly based on reams of data, such as weather statistics across the years and geographic regions. Reviewers rarely ask for data that were fed into the computers. Much less are the readers able to double test the outcomes. Not only does one have to make sense of the data, but one must also ascertain that the measurements are accurate. Measuring a location's warmth from ground level gives one reading, measuring it from space may give a different reading. Just a tiny fraction of a change may change balmy weather predictions to Antarctica cold. One cannot be sure whether predictions will materialize. The climate question is too daunting to be answered with certainty.

It is however the next question that offers a better sense of direction. What should be done about the dire predictions in case they turn out to be accurate? The answer is there is little that can be done, and whatever could be done may do more harm than good. Take the cold winter days on a northeast campus where the massive heating units warm the classrooms and dorms. These units generate pollution. Should they be turned off? If so, the students will freeze to

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death. The chemicals in the labs would freeze and possibly become inert. Life in the plant biotechnology lab would come to a halt. It would put a stop to plant transformation. Greenhouse space on campus could become unusable. Take instead the hot summer months. What could be done to reduce pollution? Turn off the air conditioners? This would make life intolerable. And what should be done about the pollution generated by commuters' cars? Stop them from driving to and from campus? What would this do to the real estate rental market in the communities surrounding the campus? How would the landlords afford to continue to pay the mortgage? Who could then reverse a collapsing economy? The domino effect of any drastic action would outweigh the benefits of the status quo.

What is in the interest of the environment may not be in the interest of those inhabiting the same environment. Environmentalists like Aldo Leopold [9], [10] would argue that the above questions represent an anthropocentrism that demeans the environment. An uncompromising non-anthropocentrist, Leopold laments man's dominance of the land. It is a mistake to treat land as an economic entity without considering the obligations towards it. He complains that land is being treated as property like Odysseus' slave-girls. Coming home from the Trojan War, Odysseus finds that his slave-girls had misbehaved during his long absence. He retaliates by hanging them. Leopold notes that "[t]he ethical structure of that day covered wives but had not yet been extended to human chattels" [9, p. 373]. Leopold complains that the environment is likewise "unprotected" by ethical arguments, as espoused in the above questions. However, anything that minimizes the role of the individual in the face of holistic intrinsic value should serve as a cautionary note since arguments' like Leopold's fail to garner widespread support. A better way to approach environmental ethics may be to recognize the interdependencies of the human and non-human dimensions of nature as a foundation for environmental ethics [11].

According to the US Environmental Protection Agency [12], as things stand right now, most electricity consumption in the United States is sourced from large-scale centralized facilities, such as fossil-fueled powered plants, connected by transmission lines to end users. Up to the first half of the 20th century, electrical utilities sprang all over the country, many times independently from each other, driven by consumer demands within local areas. However, the need for efficiency put pressure on the utilities to join and coordinate their power operations. Regional system operators united the previously fragmented operations. Thus, when a consumer turns on the electricity switch at home, the electricity may come all the way from another state and another utility company. This creates legal hurdles ranging from tribal to federal governments. Environmental concerns are also magnified with large-scale operations. Fossil fuels contaminate the environment with air pollutant emissions [13]. Burning fuel leaves a trial of mercury, nitrogen oxides, carbon dioxide and sulfur dioxide [14]-[17]. Ash may have to be collected and disposed due to hazardous substances. Water that is used for steam production may have contaminants too. Some of it is lost to evaporation. In addition to the pollution from power generation, there are also impacts associated with the transportation of certain fuels such as coal. Transmission lines crisscrossing the states compromise pristine land. It is understandable why the status quo is difficult to accept among environmentalists. However, the alternatives lack a viable and efficient storage of solar and wind energy. When dealing with low power, electricity may be stored in capacitators. With high power storage, electricity would have to first pump water up into reservoirs [18]. When the sun and wind fail to exert a significant presence, water is released, flowing down from the reservoirs through turbines which generate electricity. As shown in Fig. 1, 94% of electricity storage in the United States, is pumped hydroelectric storage. It is not economical because changing one source of power into another source of power creates efficiency problems such as with the loss of electricity during the storage process. As a result, the output is unequal to the input even if energy can neither be created nor destroyed. It can only be transformed from one energy type into another, such as from electrical energy to potential water energy. An exception to this is nuclear energy where material mass is converted into pure energy as per Einstein's E=MC2.

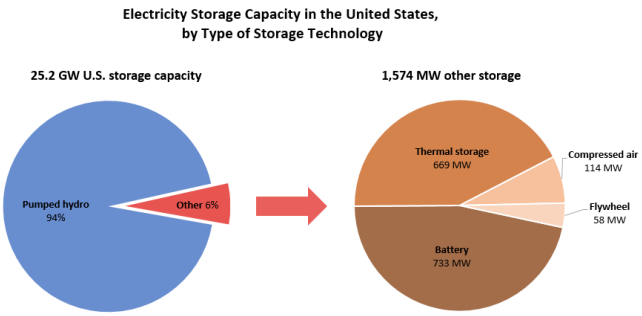

Fig. 1. https://www.energystorageexchange.org/ [Accessed March 1, 2018].

Society could continue to cover the landscape with solar panels and wind turbines, but it still does not know how to efficiently store the excess energy generated by these inventions. What happens when the wind stops blowing as it sometimes does? What happens when the sun hides behind the clouds for several days? Where would the energy come from in such circumstances? The renewable-energy industry has not figured out how to store up energy against the unpredictable weather that drives wind and solar energy. The available options are inferior alternatives to fossil fuels in that they cannot generate power around the clock under all weather outcomes. The absence of cheap ways of generating power when it is calm or cloudy limits the effectiveness of a grid driven by renewables [19]. It is likely that old technology would be relied on for a long time to address pressing energy needs. It is not that society does not want to advance to newer and cleaner technology. It is that without economical means of clean energy storage, the new technology cannot fully replace the old. The *Wall Street Journal* reported in 2013, that seven years earlier, the state of California passed a law requiring utilities to derive 33% of their power from renewables by 2020 and then cautioned that "as the state

derives more of its electricity from renewables, it needs more 'peak' gas-fired plants that can ramp up to meet demand when the sun is not shining and wind is not blowing -- namely during dawn and dusk. Otherwise, rolling blackouts could ensue" [20]. As if on cue, in August 2020, rolling blackouts darkened the state in late hot summer afternoons, during sunset, when the renewable energy supply began to wane. There were days when California's grid operator had to search on the spot market for as much as 50 percent of what it needed to keep the electricity on as sunlight and to a certain degree, wind power, tailed off [21].

Wind generation is the second-largest source of energy in Texas [22], constituting about one fourth of state power supplies. When unusual cold weather hit the state in February 2021, the deep freeze locked up about half the turbine towers, leading to a federal emergency declaration [23]. Research is in the works about de-icing methods [24]. One method is to paint the blades black to absorb UV energy. An alternative could be to plaster tiles, heated hours in advance by electricity, to prevent ice accretion. Another possibility is to use helicopters to coat old blades. However, results so far have proved mostly impractical and costly. Paint adds weight across the turbine's surface. Coating adhesion is challenging and delaminates on surfaces that vibrate under high wind.

III. Solutions

In Heller's words: "The most important argument against climate alarmism is that the proposed solutions are unworkable, dangerous and useless. They were made without consulting engineers and have zero chance of success" [6]. Niagara Falls may provide enough electricity for its neighboring communities, but such powerful waterfalls are rare and the homes around the Falls are a mere fraction of the total homes in Canada and the United States. Various renewable energy concepts may sound compelling until one delves into the required engineering architecture to support the system [25]. The scalability issue may be hard to overcome. Samaniego *et al.* describe current technology issues that still need to be addressed as they describe the challenge of creating a steady source of renewable energy for the grid [26].

Propaganda for social objectives works best when the media propagate unilateral messages uncontested by counterpropaganda [27]. Thus, in North Korea, the Communist machinery is highly effective in portraying the leader as having godlike qualities and abilities [28]. Media within the dictatorial state are not allowed to say anything to the contrary. As a result, citizens go around praising their beloved leader in their daily greetings to each other. This is not the case in the United States where the mass media are fragmented and contentious in their arguments. Even scientific facts such as the net benefits of vaccination against measles are undermined by internet sites and other media [29]. Likewise, information about global warming is vigorously probed. Different arguments are disseminated by all sides, trying to convince others about overriding views [30]. However, as educated citizens with ready access to the internet and its multiple views, it is hard to loyally adhere to one theory. The band wagon effect occurs when there is an uptake of beliefs as more and more people subscribe to an idea. In the face of opposing ideas, people are less inclined to hop on the bandwagon. It is one thing to lean in one direction, it is another to neglect opposing views. Thus, the public looks at the weather ahead and wonders what the future holds for mother earth. Without meaningful scientific alternatives that can help store excess energy, one can only watch with exasperation at the limitations. Environmental activists, such as Extinction Rebellion protesting in central London, may claim to have a blueprint for environmental success [31], [32]. If the movement had a blueprint, and it was feasible, it would save the environment. Yet, as so often happens in campaigns of this nature, proposed solutions turn out to be scientifically unworkable. Without the means to store alternative energy, one cannot do what needs to be done.

IV. Conclusion

It would be an oversimplification to accuse one side or another of unethical behavior. Ethics is a system of moral principles concerned with what is just for society and its members. Gardiner discusses the complications involved in determining whether climate change can be accurately evaluated under an ethical lens in a system that seeks to determine what is right as opposed to what is wrong [33]. All sides are trying to digest weather facts and what should be done. Just because there is lack of agreement, it does not mean that one side or the other is trying to deceive. Each side believes that it is rational and morally upright in its arguments.

Humans have been triggered since early times to fear the environment around them. Take the caveman stepping outside the cave and jumping at the sight of a long weed within the periphery of his eyesight, mistaking it for a poisonous snake. He may have looked foolish for his error but suffered no harm. Now suppose the weed was indeed a poisonous snake. Jumping out of its path would have saved his life. This would have been a tremendous benefit for his caution. The same analogy applies to the fear about the weather and the environment. If it turns out that the fear is misplaced and there is no Armageddon ahead, humanity will continue to enjoy mother earth. But if the fear is justified, then it befits that humanity does something about it. The problem, as aforementioned, is that there is no tenable solution as things stand. Shutting down the economic engines will not fix the problem. The caveman fixed the problem by jumping. Humanity cannot fix its climate problem, real or perceived, no matter what is done under the current state of scientific knowledge about workable alternatives.

As science investigates further, it will likely invent ways to store renewable energy. Up to a few decades ago, it would have been a pipe dream to produce and store biogas. Now biogas can be updated to pure biomethane and used as vehicle fuel to reduce the emission of greenhouse gases [34]. There may have been no vaccines to prevent COVID-19 when it hit in early 2020 but this did not stop scientists from successfully discovering vaccines before the end of the year. Inventing, experimenting, and making mistakes are the road to success

as science will come up with new solutions. The aspiration to build a future based on renewable energy by experimenting with, for example, compressed air, as can be seen by Hydrostor's first commercial plant in Canada, and gravity, as experimented by Swiss company, Energy Vault [19], could lead to discoveries which would make the dream come true.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

A graduate paper by Maximilian Bonnici laid down the original groundwork for this article. Henry Greene supervised the revised project. Isabelle Bonnici lent her research assistance experience in bringing the article to full fruition.

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